CHANNEL STATE INFORMATION ACQUISITION AND FEEDBACK FOR FULL DIMENSION MULTIPLE INPUT MULTIPLE OUTPUT

BACKGROUND

[0001] 1. Field

[0002] Various communication systems may benefit from feedback related to communication conditions. For example, certainly wireless communication systems may benefit from channel state information acquisition and feedback, particularly in connection with, for example, full dimension multiple input multiple output.

[0003] 2. Description of the Related Art

[0004] Full-dimension multiple-input/multiple-output (MIMO) and three-dimensional (3D) beamforming are technologies that may be used in long term evolution (LTE) release 12 (Rel 12), millimeter wave (mmWave) transmission, and beyond. Full dimension MIMO (FD-MIMO) can use a large number of transmit/receive (Tx/Rx) receivers to enable high efficiency transmission for indoor/outdoor cellular communications. The significantly increased number of antennas of FD-MIMO may provide challenges for channel estimation and channel feedback.

[0005] As mentioned above, FD-MIMO is a technology that can use a large number of transmit (Tx) antennas at an evolved Node B (eNB) in multi-user MIMO (MU-MIMO) transmissions. FD-MIMO can take advantage of the quasi-orthogonality of spatial signatures of UEs, which can use approximated weights based on antenna-wise channel estimation.

[0006] FD-MIMO operation in one example can follow the following steps: first, identify the channel state information (CSI) of the FD-MIMO channel; and second, use or design the transmit weight for MU-MIMO. As the spatial signatures of UEs are close to being orthogonal, UE pairing may be a straightforward procedure.

[0007] Conventionally, CSI can be acquired in uplink sounding for time division duplex (TDD). By contrast, for frequency division duplex (FDD), MIMO is supported by the following: UE and eNB agree upon a codebook; UE observes CRS or CSI-RS in the downlink; and UE feeds back the preferred PMI.

[0008] LTE Rel-10 channel state indicator reference symbol (CSI-RS) in the downlink can be upper limited to 8 ports. If that paradigm is followed to support FD MIMO, increasing the number of CSI ports may be possible, for example, the CSI ports may be increased to 16. There may, however, be several related issues such as the following: extremely high codebook search complexity with 16 by v dimension, where v is the rank of the codeword; and CSI port overhead and cell planning issues.

[0009] Hence, it is not conventionally straightforward to support FD MIMO for FDD. Due to the issues highlighted above with FDD when a conventional feedback framework is used, FD-MIMO may be considered for TDD, where the CSI is acquired with uplink sounding. This approach has issues, including the following: uplink sounding is a TDD only solution to acquire CSI; and substantial calibration burden is put on the radio frequency (RF) system as now one has to put calibration circuit with densely arranged antennas.

[0010] UL sounding is a general approach for network to acquire CSI in a TDD system. However, as mentioned above, it may be limited to TDD systems, and it may impose a calibration burden.

[0011] For both TDD and FDD, in a conventional CSI feedback scheme, for example in LTE Rel-10, 8 CSI-RS ports are configured for an eight-port antenna system. Also, the complex valued channel gain from one eNB antenna to a UE antenna can be estimated at UE. The channel estimate of 8 antennas can be matched with the precoding matrix in the UE's codebook, potentially considering the non-whiteness of the spatial interference the UE experiences. The precoding matrix index (PMI) can be selected and feedback to the eNB. The framework works well when the number of antenna ports is limited, such as 8 antenna ports.

[0012] When the antenna number is large, for example 64 antennas with an 8×8 antenna array, a simple extension of that framework may require dividing antennas into multiple groups and using the existing CSI feedback framework on each antenna groups, not unlike the practice in CSI feedback for coordinated multipoint (CoMP) joint transmission (JT), then multiple CSI processes may be needed to feed back sub-channels (for example, 8×1 for each) and the co-phasing terms to piece together the sub-channels into a whole observation.

[0013] A quadrant method has been proposed. In essence, in this method cell splitting is used for CSI feedback. Moreover, PMI based feedback is assumed in the quadrant method proposal.

SUMMARY

[0014] According to certain embodiments, a method can include configuring, at a base station, a plurality of reference signals as sampling points for channel state information. The method can also include restoring channel state information from feedback information from a user equipment based on the sampling points. The method can further include selecting a precoder based on channel state information for a specific user equipment.

[0015] In certain embodiments, a method can include computing an estimate of channel state information based on a limited number of samples at reference symbols. The method can also include performing at least one of explicitly feeding back the estimate to a base station; implicitly feeding back a succinct set of parameters identified in compressed sensing processing; or implicitly feeding back a succinct set of parameters extracted from a best precoder.

[0016] An apparatus, according to certain embodiments, can include at least one processor and at least one memory including computer program code. The at least one memory and the computer program code can be configured to, with the at least one processor, cause the apparatus at least to configure, at a base station, a plurality of reference signals as sampling points for channel state information. The at least one memory and the computer program code can also be configured to, with the at least one processor, cause the apparatus at least to restore channel state information from feedback information from a user equipment based on the sampling points. The at least one memory and the computer program code can further be configured to, with the at least one processor, cause the apparatus at least to select a precoder based on channel state information for a specific user equipment.

[0017] An apparatus, in certain embodiments, can include at least one processor and at least one memory including